

***Smardaea isoldae* sp. nov. from a tropical cloud forest in Mexico**

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ABSTRACT—*Smardaea isoldae* is described from Sierra Madre Oriental, Hidalgo State, Mexico. The new species is distinguished by its olivaceous coloration, habit on dead wood, and tropical cloud forest habitat. The holotype is deposited in ENCB Herbarium. A key to *Smardaea* species is presented.

KEY WORDS—*Pyronemataceae*, *Pezizales*, *Pezizomycetes*, taxonomy

Introduction

Smardaea was described by Svrček (1969) based on the type species *Ascobolus amethystinus* W. Phillips. The genus is characterized by its discoid to cupuliform apothecia and purple, blue purple, violet, dark violet, black purple to black colors. The ectal excipulum comprises globose or angular cells and the medullary excipulum is composed of interwoven septate hyphae. The operculate asci are cylindrical with inamyloid apices and the ascospores are globose, ellipsoid or fusoid with smooth, verrucose, or tuberculate walls. The apothecia are found on sandy soil, leaf litter, mosses, and decayed wood. The genus at present includes 10 species, described from Europe, Australia, and Asia: *Smardaea amethystina* (W. Phillips) Svrček, *S. australis* P.S. Catches. & D.E.A. Catches., *S. marchica* (Benkert & J. Moravec) Benkert, *S. microspora* J.Z. Cao & al, *S. ovalispora* (Grelet) Van Vooren, *S. planchonis* (Dunal ex Boud.) Korf & W.Y. Zhuang, *S. protea* W.Y. Zhuang & Korf, *S. purpurea* Dissing, *S. reticulosperma* (Donadini & al) Benkert, and *S. verrucispora* (Donadini &

Monier) Benkert (Svrček 1969, Brummelen 1969, Dissing 1985, Zhuang & Korf 1986, Cao & al. 1990, Korf & Zhuang 1991, Benkert 2005, Van Vooren 2009, Moyne & al. 2010, Catcheside & al. 2017). Only *S. planchonii* has been reported from the western hemisphere (Seaver 1942: Bermuda; Gamundí 1960: Argentina; Hanlin 1965 and Pfister 1985: USA). During taxonomic work in the Sierra Madre Oriental of Hidalgo state, Mexico, several specimens of a *Smardaea* growing on dead wood in tropical cloud forest could not be placed in any previously described species. Here we describe and illustrate those specimens as *Smardaea isoldae*.

Materials & methods

The specimens were collected during 2012–2018 from two localities in a tropical cloud forest of Tlanchinol municipality, State of Hidalgo, Sierra Madre Oriental, Mexico. They are deposited in the “Dr. Gastón Guzmán Huerta” fungal collection of the Herbarium of the Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, Mexico City, Mexico (ENCB). Georeferences were obtained with Garmin eTrex® GPS. Color codes follow Kornerup & Wanscher (1978). Microscopic observations were taken from tissues rehydrated in 5% aqueous KOH and Melzer’s reagent; ascospore dimensions include the ornamentation. Macroscopic features were photographed with a Nikon D7000 camera and the micrographs with a Sony DSC-WX350. For the SEM studies, the sample was prepared according to the critical-point-drying method outlined in Moreno & al. (1995) and examined with a JSM-5800LV scanning electron microscope. Most terminology follows Ulloa & Hanlin (2012), with Ekanayaka & al. (2017) for the types of ectal and medullary excipulum.

Taxonomy

Smardaea isoldae Raymundo & R. Valenz., sp. nov.

PLATES 1–3

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Differs from *Smardaea amethystina* by its olive green, greyish green, dark green to olive brown hymenium; its larger ascospores; and its habitat on dead wood in a tropical cloud forest.

TYPE: Mexico, Sierra Madre Oriental, Hidalgo State, Tlanchinol municipality, El Temazate, 21°01′40″N 98°38′33″W, alt. 1500 m, 31 May 2018, R. Valenzuela 18324 (Holotype, ENCB).

ETYMOLOGY: In honor of Dr. Isolda Luna Vega, pioneer in the study of fungal biogeography in Mexico.

APOTHECIA 2–4 mm diam., sessile on a broad base, pulvinate, cup shaped when young, then flattened to discoid, flesh soft to gelatinous, dark olive (3F3) to black, yielding yellow (3A8) KOH-extractable pigments. HYMENIUM 300–320 µm thick, smooth, olive green (3D7) or olive (3F7) when young, then

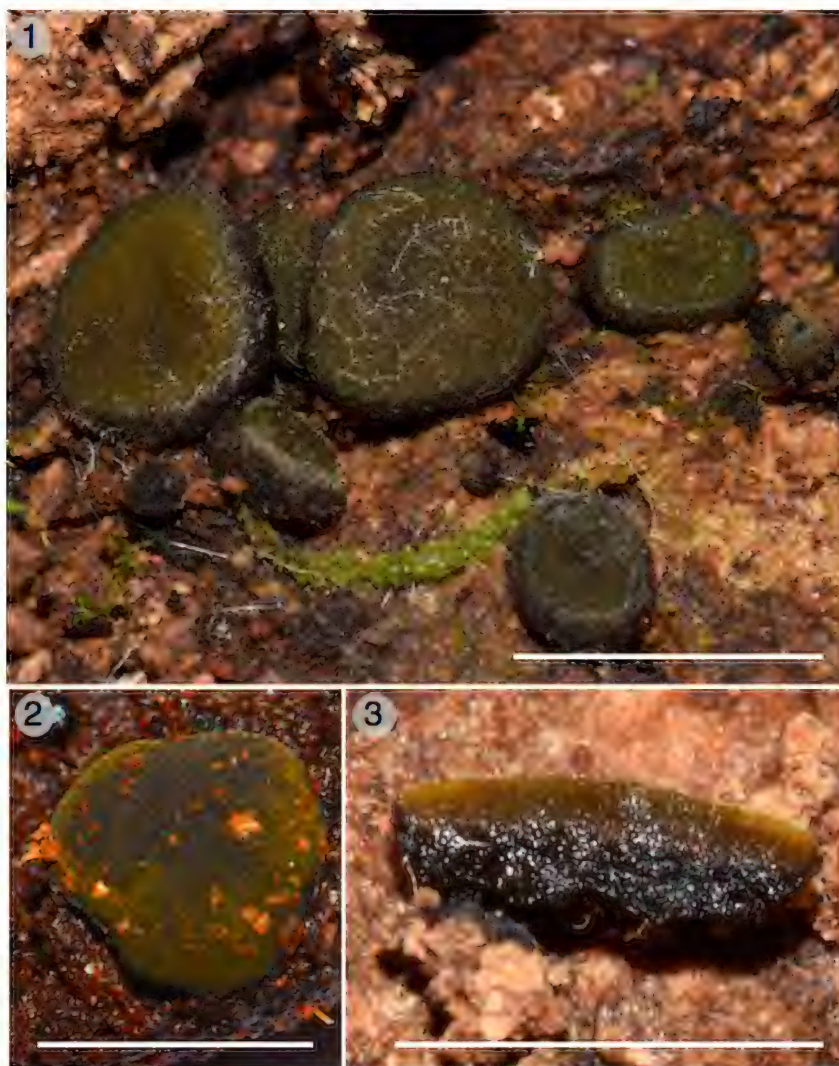


PLATE 1. *Smardaea isoldae* (holotype, ENCB Valenzuela 18324). 1. Gregarious young and mature apothecia on dead wood; 2. Mature discoid apothecium; 3. Apothecium, transverse section. Scale bars = 5 mm.

olive gray (3E2), olive brown (4E5, 4F6), dull green (30E3), or greyish green (30E7), black in dry specimens. EXTERNAL SURFACE olive grey (3F2), dark olive (3F3), brownish grey (4F2), dark olive brown (4F3) to black, slightly rugose.

ECTAL EXCIPULUM 90–120 μm thick at the margin and ≤ 200 μm thick in the base, textura globulosa to angularis from base to margin, globose cells 15–28 μm diam., subglobose to elongated cells 16.5–42.5(–60) $\times$ 10–20(–25) μm ; walls ≤ 3 μm thick, amber (6D6), wine red (11D8) to deep magenta (13–14D8). MEDULLARY EXCIPULUM 260–300 μm thick, textura intricata intermixed with globose to subglobose cells, hyphae 2.5–7.5 μm diam., pale yellow to light purplish in KOH, septate, branched, thin-walled, globose to subglobose cells 8–15(–25) μm broad, walls ≤ 2 μm thick, pale yellow to light purplish in KOH. SUBHYMENIUM 15–25 μm thick, textura globulosa mixed with few short, branching, septate, thin-walled hyphae, 2–4 μm diam, globose to subglobose cells, 3–7 μm diam., thin-walled, hyaline to pale yellow in KOH. PARAPHYSES 300–340 μm long, filiform, ≤ 25 μm beyond the asci, 2–4 μm diam., unbranched, septate, hyaline, pale yellow to light purple in KOH, with swollen apex, clavate to capitate, 6–12 μm diam. at the top. ASCI operculate, inamyloid, 8-spored, 270–300 $\times$ 16–18(–20) μm , cylindrical, hyaline. ASCOSPORES 22–28 $\times$ 10–14 (–15) μm , oblong to fusiform, hyaline in KOH, inamyloid, surface covered by coarse, hyaline, rounded warts or tubercles, 1.5–3 μm high, and semiglobular apiculi at the ends, 2–4 μm high and 3.5–5.5 μm wide.

ECOLOGY AND DISTRIBUTION—gregarious on decayed angiosperm wood in a tropical cloud forest.

ADDITIONAL SPECIMENS EXAMINED—MEXICO. HIDALGO, Tlanchinol municipality, El Temazate, 21°01'40"N 98°38'33"W, alt. 1500 m, 17 May 2014, R. Valenzuela 15477, T. Raymundo 5070, 5083, 5090, 5091 (all in ENCB); Parador la Montaña, 21°01'40"N 98°38'34"W, alt. 1500 m, 27 May 2012, T. Raymundo 4188, R. Valenzuela 14695, S. Bautista-Hernández 17; C. Santamaria 19 (all in ENCB).

COMMENTS—*Smardaea* has been described with purple pigments in the apothecia and with differently shaped and ornamented ascospores. The olive green to dull green hymenium and dark olive to black external surface colors of our Mexican specimens are unusual in *Smardaea*, but the textura of ectal and medullary excipulum corresponds to the structure described for the genus, and the spore ornamentation for *S. isoldae* is similar to that of the type species (*Smardaea amethystina*). *Aleurina* also exhibits an olivaceous, olivaceous brown, brown, or purplish brown hymenium when fresh, and some *Aleurina* species have ascospores ornamented with rounded warts similar to *Smardaea amethystina* and *S. isoldae* (Zhuang & Korf 1986). However, these *Smardaea* species have semiglobular apiculi at the ends, which are not present in *Aleurina* species (Zhuang & Korf 1986), supporting the Mexican material in *Smardaea*. Perry & al. (2007) supported *Aleurina* and *Smardaea* as independent genera because they are in different clades.



PLATE 2. *Smardaea isoldae* (holotype, ENCB Valenzuela 18324). 4. Apothecium, transverse section; 5. Ectal excipulum in margin; 6. Medullar excipulum; 7. Basal ectal excipulum with textura globulosa to prismatica and medullar excipulum with textura intricata; 8. Marginal ectal excipulum (textura globulosa to prismatica). Scale bars = 4 = 300 μ m; 5–8 = 100 μ m.

Smardaea isoldae is characterized by the green to olivaceous hymenium and external surface, shape, size, and ornamentation of the ascospores and its growth on dead wood in a tropical cloud forest. Our new species resembles *Smardaea amethystina* in spore ornamentation and the semiglobular apiculi, but *S. amethystina* differs in its purple apothecial color, smaller ($19.5\text{--}22 \times 11\text{--}12.5 \mu\text{m}$) ascospores, and sandy substrate (Brummelen 1969, as *Jafnadelpus amethystinus*). The other *Smardaea* species (i.e., *S. australis*, *S. marchica*, *S. planchonis*, *S. reticulosperma*, *S. verrucispora*) differ in their globose to subglobose ascospores. Ascospores of several other species share the ellipsoid to oblong or fusoid shape found in *S. isoldae* but are characterized by a finely rugose, subreticulate to reticulate ornamentation; *S. ovalispora*, *S. microspora*, *S. protea*, *S. purpurea*, *S. australis*, and *S. planchonis* have smooth to very finely ornamented spores (Donadini 1976, 1984, Torre & al. 1988, Benkert 2005, Seaver 1942, Hanlin 1965).

Key to species of *Smardaea*

- 1. Ascospores globose to subglobose 2
- 1. Ascospores ellipsoid to fusiform 6
- 2. Ascospores finely verrucose to reticulate..... 3
- 2. Ascospores smooth, $8\text{--}10.5\text{--}(11.5) \mu\text{m}$ diam..... *S. australis*
Apothecia (3–)5–15 mm diam., cupulate, hymenium fuscous-black, violaceous black to blackish-purple; paraphyses filiform, straight or slightly curved, sparsely septate, tips slightly swollen, $2\text{--}7 \mu\text{m}$ diam.; known only from Australia, associated with moss: *Leucopogon parviflorus*, *Melaleuca* sp., and *Acacia longifolia* subsp. *sophorae*, on low sand dune (Catcheside & al. 2017: 19)
- 3. Ascospores globose, $9\text{--}12 \mu\text{m}$ diam., smooth, warted or reticulate 4
- 3. Ascospores subglobose, $13\text{--}15 \times 12\text{--}14 \mu\text{m}$, coarsely warted. *S. marchica*
Apothecia 4–5 mm diam., discoid, dark violaceous brownish to almost black; paraphyses filiform, septate, unbranched, apex swollen, $4\text{--}7\text{--}(11) \mu\text{m}$ diam.; known only from Germany growing on sandy soil under *Pinus sylvestris* (Benkert & Moravec 1986: 89, Benkert 2005: 144, 151)
- 4. Ascospores coarsely verrucose or reticulate 5
- 4. Ascospores smooth to minutely verrucose *S. planchonis*
Apothecia 10–20 mm diam., discoid to cupulate, hymenium violaceous purple to black purple; paraphyses filiform, simple to branched, septate, apex slightly swollen $4.5\text{--}8 \mu\text{m}$ diam.; known from Europe, Bermuda, USA, and Argentina growing in sandy soil or leaf litter under *Cupressaceae* in Europe, *Yucca* in USA (Seaver 1942: 74, Hanlin 1965: 135, Donadini 1976: 256)

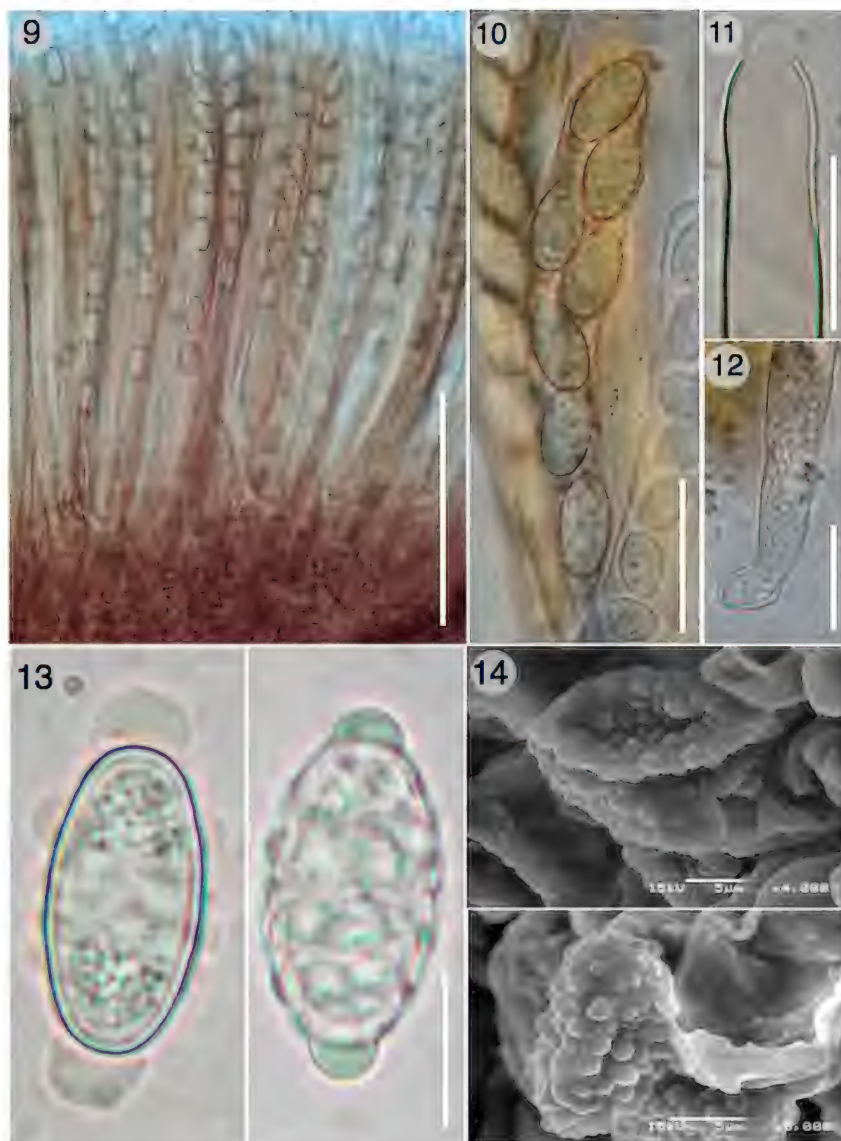


PLATE 3. *Smardaea isoldae* (holotype, ENCB Valenzuela 18324). 9. Hymenium with asci, ascospores, and paraphyses; 10. Asci and ascospores; 11. Operculate ascus; 12. Base of ascus; 13. Ascospores in 5% KOH; 14. Ascospores in scanning electronic microscope (SEM). Scale bars: 9 = 100 μ m; 10–12 = 20 μ m; 13 = 10 μ m.

5. Ascospores verrucose (warts $\leq 1 \mu\text{m}$ high), 9–12 μm diam. *S. verrucispora*
 Apothecia 5–15 mm diam., cupulate, hymenium violet to purple; paraphyses filiform, straight or slightly curved, branched at base or simple, septate, tips slightly swollen 3.5–5 μm diam.; known only from France on humus under cedars (Donadini 1976: 259)
5. Ascospores reticulate, 10–11 μm diam. *S. reticulosperma*
 Apothecia 10–40 mm diam., cupulate, hymenium violet to purple; paraphyses filiform, slightly curved, branched, septate, tips slightly swollen 3–5 μm diam.; known only from France on humus under *Cedrus atlanticus* (Donadini 1986: 54, 58)
6. Ascospores oblong to fusiform, more than 15 μm long 7
6. Ascospores ellipsoid, smooth, 12–14 $\times$ 8–9(–10) μm *S. ovalispora*
 Apothecia 8–15 mm diam., cupulate, hymenium violet; paraphyses filiform, curved at apex, branched at base, septate, tips slightly swollen 2.5(–4) μm diam.; known from France and Spain on humus under *Pinus halepensis*, *Pinus sylvestris*, and *Cedrus atlanticus* (Donadini 1976: 258, Van Vooren 2009: 23, 24)
7. Ascospores with irregular lower ridges to reticulate 8
7. Ascospores finely verrucose to tuberculate 9
8. Ascospores finely reticulate when mature,
 ornamentation $\leq 0.5 \mu\text{m}$ high *S. microspora*
 Apothecia 3–6 mm diam., discoid, hymenium purple to black purple; paraphyses filiform, unbranched, septate, tips swollen 4–7.5 μm diam.; known only from China on sandy soil (Cao & al.1990: 283)
8. Ascospores coarsely warted to reticulate when mature,
 ornamentation 1–3 μm high *S. purpurea*
 Apothecia 2.5–7 mm diam., discoid, hymenium purple; paraphyses filiform, branched, septate, tips slightly swollen 3–4 μm diam.; known from Europe under *Alnus incana* in shadowed, rich, moist soil and from China under conifers (Dissing 1985: 36, 37; Cao & al.1990: 283; Moyne & al.2010: 8)
9. Ascospores coarsely warted to tuberculate, rounded warts 1.5–3 μm high and semiglobular apiculi at the ends, 2–4 μm high and 3.5–5.5 μm across 10
9. Ascospores finely verrucose, warts angular to irregular up to 0.7 μm high, semiglobular apiculi at the ends absent *S. protea*
 Apothecia 5–12 mm diam., cupulate to discoid, hymenium purple to dark purple; paraphyses filiform, slightly enlarged at apex, up to 6.5 μm diam.; known only from Czech Republic on sandy soil (Zhuang & Korf 1986: 380, Benkert 2005: 143, 151)
10. Apothecia dark purplish violet or blackish violet,
 ascospores (18–)19.5–22(–23) $\times$ (9.5–)11–12.5(–13) μm *S. amethystina*
 Apothecia 4–20 mm diam., first cupulate then discoid; paraphyses filiform, unbranched, septate, tips swollen 4–5 μm diam.; known from Europe under *Salix*, *Alnus*, *Corylus*, and *Laurus* on sandy soil (Brummelen 1969: 225, Iglesias 2010: 35, 36)
10. Apothecia olive gray, olive brown, dull green to greyish green,
 ascospores 22–28 $\times$ 10–14(–15) μm *S. isoldae*
 Apothecia 3–8 mm diam., cupulate when young, then flattened to discoid; paraphyses filiform, unbranched, septate, with swollen apex, clavate to capitate, 6–12 μm diam.; known only from Mexico on decayed wood.

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